

Mark schemes

1	(a) dark matt	1
	light shiny	1
	(b) B A C	1
	biggest temperature difference (80 °C) <i>dependent on first mark</i>	1
	(c) (i) (the can that is) dark matt	1
	best absorber (of infrared radiation)	1
	(ii) any three from:	
	• same area / shape of can	
	• surrounding temperature is the same for all cans	
	• same surface underneath cans	
	• same position in the room	3
	(d) fox A	
	smaller ears	1
	thicker fur	1
	these minimise energy transfer <i>dependent on first 2 marks</i>	1
		[12]
2	(a) (black) is a good absorber of (infrared) radiation	1
	(b) (i) amount of energy required to change (the state of a substance) from solid to liquid (with no change in temperature) <i>melt is insufficient</i>	1
	unit mass / 1kg	1

- (ii) 5.1×10^6 (J)
accept 5×10^6
allow 1 mark for correct substitution ie $E = 15 \times 3.4 \times 10^5$ 2
- (c) (i) mass of ice
allow volume / weight / amount / quantity of ice 1
- (ii) to distribute the salt throughout the ice 1
 to keep all the ice at the same temperature 1
- (iii) melting point decreases as the mass of salt is increased
allow concentration for mass
accept negative correlation
*do **not** accept inversely proportional* 1
- (d) 60 000 (J)
accept 60 KJ
allow 2 marks for correct substitution ie $E = 500 \times 2.0 \times 60$
*allow 2 marks for an answer of 1000 **or** 60*
allow 1 mark for correct substitution ie
 *$E = 500 \times 2.0$ **or** $0.50 \times 2.0 \times 60$*
allow 1 mark for an answer of 1 3

- (e) Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response. Examiners should also apply a 'best-fit' approach to the marking.

0 marks

No relevant content

Level 1 (1–2 marks)

There is *an attempt at a description of some advantages or disadvantages.*

Level 2 (3–4 marks)

*There is a basic description of some advantages **and** / **or** disadvantages for some of the methods*

Level 3 (5–6 marks)

There is a clear description of the advantages and disadvantages of all the methods.

examples of the points made in the response

extra information

energy storage

advantages:

- no fuel costs
- no environmental effects

disadvantages:

- expensive to set up and maintain
- need to dig deep under road
- dependent on (summer) weather
- digging up earth and disrupting habitats

salt spreading

advantages:

- easily available
- cheap

disadvantages:

- can damage trees / plants / drinking water / cars
- needs to be cleaned away

undersoil heating

advantages:

- not dependent on weather
- can be switched on and off

disadvantages:

- costly
- bad for environment

6
[18]

3	(a) infrared / IR	<i>correct answer only</i>	1
	(b) any two from:	<ul style="list-style-type: none"> • increase the power / watts <i>allow increase the temperature of the oven or make the oven hotter</i> • decrease the speed <i>allow leave the biscuits in for longer</i> • put biscuits through again <i>increase radiation is insufficient</i> <i>ignore changes to the design of the oven</i> 	2
	(c) (inside) surface is a (good) reflector or poor absorber (of IR)	<i>Ignore bounce for reflect</i> <i>surface is a (good) reflector of light does not score</i> <i>surface is a (good) reflector of light and infrared / heat does score</i>	1
	(and) <u>outside</u> surface is poor emitter (of IR)		1
	(so) increases the energy reaching the biscuits	<i>allow reduces energy loss or makes oven more efficient</i> <i>do not accept no energy losses</i> <i>keeps oven hotter is insufficient</i>	1
			[6]
4	(a) to reflect (the infrared)	<i>accept (shiny surfaces) are good reflectors</i> <i>ignore reference to incorrect type of wave</i>	1
	(b) black		1
	best absorber (of infrared)	<i>answer should be comparative</i> <i>black absorbs (infrared) is insufficient</i> <i>accept good absorber (of infrared)</i> <i>ignore reference to emitter</i> <i>ignore attracts heat</i> <i>ignore reference to conduction</i>	1

- (c) to reduce energy loss

*accept to stop energy loss
accept heat for energy
accept to stop / reduce convection*

or

so temperature of water increases faster

*accept to heat water faster
accept cooks food faster*

or

reduces loss of water (by evaporation)

1

- (d) 672 000

allow 1 mark for correct substitution, ie $2 \times 4200 \times 80$ provided no subsequent step shown

2

[6]**5**

- (a) (matt) black is a good
- emitter
- of infrared / radiation

*accept heat for infrared / radiation
ignore reference to good absorber
attracts heat negates this marking point*

1

to give maximum (rate of) energy transfer (to surroundings)

*accept temperature (of coolant) falls fast(er)
accept black emits more radiation for 1 mark
black emits most radiation / black is the best emitter of radiation for 2 marks*

1

- (b) the fins increase the surface area

accept heat for energy

1

so increasing the (rate of) energy transfer

or

so more fins greater (rate of) energy transfer

1

- (c) 114 000

allow 1 mark for correct temperature change, ie 15 (°C)

or

*allow 2 marks for correct substitution, ie $2 \times 3800 \times 15$
answers of 851 200 **or** 737 200 gain 2 marks*

or

*substitution $2 \times 3800 \times 112$ **or** $2 \times 3800 \times 97$ gains 1 mark
an answer of 114 kJ gains 3 marks*

3

(d) increases the efficiency

1

less (input) energy is wasted

accept some of the energy that would have been wasted is (usefully) used

or

more (input) energy is usefully used

accept heat for energy

1

[9]

6

(a) (i) to check rise in temperature (of other thermometers) was due to the (different wavelengths of) light

accept as a control / comparison

to measure room temperature is insufficient

1

(ii) any **two** from three:

- different colours produce different heating effects / (rises in) temperatures
- red light produces the greatest heating effect / (rise in) temperature

or

- violet produces the least heating effect / (rise in) temperature
- all colours produce a greater heating effect than outside the spectrum

an answer

the longer the wavelength the greater the (rise in) temperature

or

the lower the frequency the greater the (rise in) temperature gains both marks

2

(b) move a thermometer into the infrared region / just beyond the red light

allow use an infrared camera / infrared sensor

1

the temperature increases beyond 24(°C)

accept temperature higher than for the red light

1

(c) $v = f \times \lambda$

9.4×10^{-6}

accept 9.375×10^{-6} or 9.38×10^{-6} **or**

0.0000094

*accept 0.000009375***or** *0.00000938**allow 1 mark for correct substitution**ie $3 \times 10^8 = 3.2 \times 10^{13} \times \lambda$*

2

(d) at night the surroundings are cooler

*accept at night the air is colder**there is no heat from the Sun is insufficient***or**

at night there is a greater temperature difference between people and surroundings

1

(so surroundings) emit less infrared (than in daytime)

*accept camera detects a greater contrast***or**

gives larger difference in infrared emitted (between people and surroundings)

1

[9]**7**(a) any **two** from:

- black is a good emitter of (infrared radiation)
accept heat for radiation
ignore reference to absorbing radiation
- large surface (area)
- matt surfaces are better emitters (than shiny surfaces)
accept matt surfaces are good emitters
ignore reference to good conductor

2

$$\text{efficiency} = \frac{\text{useful energy out} (\times 100\%)}{\text{total energy in}}$$

allow 1 mark for correct substitution, ie $\frac{13.5}{15}$

provided no subsequent step shown

an answer of 90 scores **1** mark

an answer of 90 / 0.90 with a unit scores **1** mark

2

(c) (producing) light

allow (producing) sound

1

(d) any **two** from:

- wood is renewable

accept wood grows again / quickly

accept wood can be replanted

- (using wood) conserves fossil fuels

accept doesn't use fossil fuels

- wood is carbon neutral

accept a description

cheaper / saves money is insufficient

2

(e) $E = m \times c \times \theta$

2 550 000

allow **1** mark for correct substitution

ie $100 \times 510 \times 50$

provided no subsequent step shown

answers of 1 020 000, 3 570 000 gain **1** mark

2

joules /J

accept kJ / MJ

do **not** accept j

for full credit the unit and numerical answer must be consistent

1

[10]

8

(a) (i) The volume of boiling water.

1

- (ii) any **one** from:
- (more) precise
*do **not** accept better (reading)*
 - accurate
 - reliable
*do **not** accept thermometer is unreliable*
 - removes human / reading error
accept easier to read
accept take temperature more frequently

1

(b) **B***marks are for the explanation*

temperature falls faster

*this mark point cannot score if **A** chosen*

1

because black is a better / good emitter

*ignore reference to better absorber**accept for both marks an answer in terms of why **A** is the white can*

1

(c) (i) faster than

1

(ii) darker / black surfaces absorb heat faster

*accept black is a better / good absorber**dark surfaces attract heat negates this mark*

1

(iii) air is a bad / poor conductor**or**air is a good insulator*accept air is an insulator*

1

[7]**9**

(a) (i) convection

1

(ii) conduction

1

(b) (i) 2

1

black is the best absorber (of thermal energy / heat)
accept black is the best emitter (of thermal energy / heat)
note that a comparative is needed (eg better or best)

1

(ii) the colour of the metal plates

1

(iii) any **one** from:

- more precise / accurate / reliable
*do **not** accept better reading*
*do **not** accept thermometer is unreliable*
- can measure continuously
- take many readings in a small time
- removes (human) reading error
accept easier to read
- can compare / draw graphs automatically
- records data automatically

1

(c) (i) radiation

accept radiates
accept infra red (IR) waves
*do **not** accept heat waves*

1

(ii) to reflect (heat away from the fire fighter)

accept it reflects
accept it is a poor absorber (of thermal radiation / heat)
*do **not** accept deflect / bounce for reflect*

1

(d) **N***the mark is for the reason which does not score if **M** is chosen*

transfers / absorbs less heat

or

gives smallest increase in temperature

*accept will keep fire fighters cooler**accept **N** is cooler (after 15 minutes)**an answer **N** goes up to 52°C and **M** goes up to 100°C is insufficient*

1

[9]**10**(i) *this mark only scores if a correct pair is chosen **and** a correct reason given***A and C***both required and none other***or****B and D***both required and none other*

only one (independent) variable

or

different shapes but the same colour

accept only the shape changes

1

(ii) **B radiates** heat faster*converse answer in terms of **A** gains full marks*

1

orB is a better emitter (of heat)but B has a smaller (surface) area**or**B has a smaller (surface) area: volume ratio*allow **2** marks for both lose the same quantity / amount of heat in the same time****or** both have same rate of heat loss**allow **1** mark for both lose the same quantity / amount of heat*

1

(iii) any **one** from:

- transfer a lot of heat (too rapidly)
- water temperature drops too rapidly
accept (significantly) more heat will be lost from the first radiator
- water too cold for the next radiator
mention of absorption of heat negates mark

1

[4]**11**

(a) (i) radiation

ignore thermal / infrared

1

(ii) black is a better / good absorber (of heat / radiation)

*ignore reference to black being a good emitter
black absorbs heat is insufficient
do **not** accept black attracts / absorbs the Sun
do **not** accept black attracts heat*

1

(so) temperature rises faster

must be an indication of heating up quicker

or

white is a worse / poor absorber (of heat / radiation) (1)

accept white is a better / good reflector (of heat / radiation)

(so if white faces) temperature would rise slower (1)

ignore any reference to light

1

(b) (i) 1.2 (hours) **or** 1 hour 12 minutes

no tolerance

1

(ii) increases (rapidly at first then increases at a slower rate)

*do **not** accept increases at a steady rate*

1

(c) (i) any **two** from:

- (fill with) same mass / volume / amount of water
- same level of (sun)light / sunshine
accept same heat / light source
accept same place
- outside for the same (length of) time
- outside at same time (of day / year)
- initial water temperature
- the side of the bag facing the Sun
*do **not** accept any factors to do with the construction of plastic bags*
eg thickness

2

(ii) curved line drawn above given line

- both lines must start from the same point*
ignore if continues beyond one hour or levels off after 1 hour
*do **not** accept a straight line*

1

[8]

12

(a) (i) silvered surfaces

more than the correct number of ticks in a row negates the mark

radiation

2

plastic cap

conduction, convection (both required)

	conduction	convection	radiation	
vacuum	✓	✓		
silvered surfaces			✓	(1)
plastic cap	✓	✓		(1)

(ii)

any mention of air or any other substance in a vacuum scores zero

because there are no particles in a vacuum

accept atoms / molecules for particles

accept vacuum is empty space

accept there is nothing in a vacuum

accept there is no air / gas in the vacuum

conduction **and** convection need particles / medium

*need reference to both conduction **and** convection*

accept correct descriptions

2

(b) (i) less heat lost (to air above the heater)

*do **not** accept **no** heat lost*

light shiny surfaces are poor emitters (of radiation)

accept radiators for emitters

references to reflection are neutral

or dull, matt surfaces are good emitters (of radiation)

*do **not** credit answers which infer reflection from the underside of the hood*

ignore correct reference to absorption

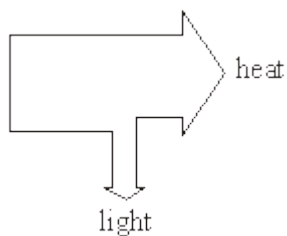
2

(ii) correct diagram drawn with one output arrow narrower than the other

ignore input

arrows correctly labelled with energy form

eg



flow charts score zero

2

(iii) energy cannot be destroyed

accept (principle of) conservation of energy

*do **not** accept because energy cannot be lost without clarification*

1

[9]**13**

(a) the bigger the surface area, the faster the water cools down / temperature falls

answers must imply rate

accept heat for temperature provided rate is implied

*do **not** accept cools down more unless qualified*

1

(b) any **two** from:

the ears:

- have large surface / area
not just has large ears

- radiate heat
*accept loses heat, but does not score
if the reason given for heat loss is wrong*

- keep blood cooler

2

(c) (i) radiation

1

(ii) conduction

1

[5]**14**

(a) conduction

*do **not** accept conductor*

1

(b) the freezer

both parts needed

greater temperature difference (between freezer and room)

*do **not** accept because it is the coldest*

1

(c) any **two** from:

- poor absorber of heat / radiation
accept does not absorb heat poor emitter of heat / radiation is neutral
- reflects heat / radiation (from room away from fridge-freezer)
- reduces heat transfer into the fridge-freezer
- reduces power consumption of fridge-freezer
*do **not** accept it is a bad conductor / good insulator*

2

[4]

15

(a) (i) 25 (%)

*do **not** accept 1/4*

1

(ii) increases

1

(b) tick (✓) in top and bottom box

both required

1

(c) SHINY surfaces are good reflectors of infra-red radiation

accept white for shiny

or black surfaces are POOR reflectors of infra-red radiation

accept bad for poor

accept insertion of 'not' before 'good' in statement

or black surfaces are good EMITTERS of infra-red radiation

or black surfaces are good ABSORBERS of infra red radiation

1

[4]

16

(a) the outside colour of the cans

1

(b) (i) 18 (°C) **or** 88 to 70

ignore negative sign

1

(ii) 8 (°C) **or** 70 to 62

ignore negative sign

1

(c) greater temperature difference between water and surroundings (at start)

must mention temperature difference

ignore just water hotter

accept energy used to heat cans initially

1

(d) black

1

temperature falls the fastest (in L)

accept (can L) loses more heat / cools quicker

accept heat for temperature

1

black is a good / the best / better emitter (of heat / radiation)

accept converse

ignore black is best absorber

1

[7]

17

(a) ions / electrons gain (kinetic) energy

accept atom / particles / molecules for ion

accept ions vibrate faster

accept ions vibrate with a bigger amplitude

accept ions vibrate more

do not accept ions move faster

1

(free) electrons transfer energy by collision with ions

or energy transferred by collisions between vibrating ions

1

- (b) move faster or take up more space
do **not** accept start to move / vibrate
1
- (warmer) water expands **or** becomes less dense (than cooler water)
do **not** accept answers in terms of particles expanding
1
- warm water rises (through colder water) **or** colder water falls to take its place
1
- (c) transfer of energy by waves / infrared (radiation)
accept rays for waves
do **not** accept transfer of energy by electromagnetic waves
ignore reference to heat
1
- [6]**

18

- (a) (i) vacuum
do not allow stopper
1
- (ii) (absence of particles) means no (transfer of energy between) particles for conduction
accept particles **or** atoms **or** molecules **or** electrons
1
- no movement of molecules for (transfer of energy by) convection
accept particles/atoms/electrons
if answer to (a)(i) is correct: then in (a)(ii) have stated 'conduction and convection both need a medium/particles/materials'
= 2 marks
(If medium is specified, it must be correct, conduction can be solid, liquid or gas, convection must be liquid or gas)
if answer to (a)(i) is incorrect then in (a)(ii) have stated 'conduction and convection both need a medium...' = 1 mark, unless further qualified by stating about absence of particles, in which case get a second mark.
1
- (b) (i) silvered surface
accept silver surface
1

(ii) silvered is a bad emitter/radiator

1

surface reflects heat/energy/radiation (at inner and outer surface)

or is a bad absorber (of energy)

accept bounces off

1

[6]

19

(i) radiation **or** infra red

do not accept rays

do not accept waves

accept electromagnetic waves

1

(ii) good absorber (of heat) to absorb heat (**or** infrared)

do not accept 'attract' or 'capture' or soak

1

(iii) reduce heat loss (from the panel)

accept (good) (heat) insulator

accept stop or reduce conduction

accept stop or reduce convection

accept traps heat

accept keeps water hot

1

(iv) to reflect (back into the panel) heat **or** infrared **or** Sun's energy

do not accept 'bouncing'

do not accept reflect Sun

do not accept reflect sunlight or sun's rays

1

radiated **or** given out by the (black) pipe

accept back to pipe

accept reduce heat loss for 1 mark

accept reduce heat loss by radiation for 2 marks

accept stop heat loss by radiation for 1 mark

1

[5]

20	(a) (i) Carries heat up (as convection current)	1
	(ii) (1) By conduction or from molecule to molecule (2) By radiation or as IR	2
	(iii) Use shiny surface (inside or outside) or small area	1
	(b) (i) Rise more quickly	1
	(ii) Dull surface good absorber (accept "attract" = "absorb" if context correct, then penalise spg mark. Shiny surface poor absorber	2
	(c) (i) Fall more quickly	1
	(ii) Dull surface good emitter Shiny surface poor emitter	2
		[10]

21	(a) convection air is heated by the burner / particles gain energy air expands / particles move about more / particles move faster air becomes less dense / particles are more spread out air rises / particles rise - <i>not</i> heat rises air from C moves into the heater / particles from C move into the heater to replace it / them <i>any four for 1 mark each</i>	4
-----------	---	---

- (b) (i) radiation
for one mark 1
- (ii) black surface radiates / emits well
(*allow* absorbs and emits well) (*allow* comparison with shiny / white surfaces)
- large surface area needed
high temperature (of the lumps)
any one for 1 mark 1
- [6]**

- 22** absorber 1
- reflector 1
- emitter 1
- [3]**

- 23** (i) D, C **or** B, in either order, then A
tick or cross on the A 1
- (ii) matt absorbs energy (better than shiny)
the converse arguments are acceptable 1
- black absorbs energy (better than white) 1
- [3]**

- 24** (a) radiates
absorbs / conducts
reflects
for 1 mark each 3

- (b) C make sure the lamp is the same distance from both tubes
- B switch on the lamp
- A switch off the lamp
- E wait for the temperature to stop rising
- D read the thermometers

for 1 mark each

5

[8]